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SUMMARY OF RESULTS OF TESTS BY THE BUREAU OF ENTOMOLOGY DURING THE SEASON OF 1932 ON THE RELATIVE EFFECTIVENESS OF COLORED AND UNCOLORED CALCIUM AND LEAD ARSENATES SUBMITTED BY THE MANUFACTURING CHEMISTS' ASSOCIATION OF THE UNITED STATES

Because of proposed and enacted legislation requiring the coloring of insecticides, the Manufacturing Chemists' Association of the United States represented by its Secretary, Mr. W. N. Watson, made a special arrangement with the Chief of the Bureau of Entomology in April 1932 to have tested by the Bureau, experimental samples of colored calcium and lead arsenates in order to find out how these arsenicals could be colored without detriment to their use and value as insecticides. The Chief of the Bureau agreed to have these tests made at various field stations of the Bureau with the understanding that the Bureau would deal entirely with the Manufacturing Chemists' Association and not with individual manufacturers.

Field and laboratory tests were made during the season of 1932. Reports by the men who made the tests were turned over for summarization to F. L. Campbell and J. W. Bulger of the Bureau in December 1932. The following brief summary of the more important results was prepared for the Manufacturing Chemists' Association. A more extensive summary containing details of the tests and data will be written later.

The samples tested were submitted by the following companies:

Ansbacher-Siegle Corporation
Chipman Chemical Company
Commercial Chemical Company
General Chemical Company
Grasselli Chemical Company
Lucas Kil-Tone Company
Niagara Sprayer & Chemical Company

Each company furnished with its colored samples an uncolored sample for comparison. The different companies used different dyes and pigments so as to provide a comprehensive series of preparations for testing. The colored products of a company were always compared with the uncolored product of that company. Usually the tests were arranged in pairs (colored vs. uncolored) so that results were not obtained on the relative effectiveness of two or more colored products of the same company. No attempt was made to compare the products of one company with those of another.

The writers of the present report have as a rule not attempted to analyze or interpret the data submitted by the men who made the tests, but rather have accepted their opinions and conclusions as stated by them. Since, with few exceptions noted in this report, the men who made the tests did not find significant differences in usableness or insecticidal value between the colored and uncolored samples, their relative effects are designated in the following tables simply by +, =, and - signs. The + sign indicates that the colored sample was apparently slightly more effective than the corresponding uncolored sample, = indicates no measurable difference, - indicates that the colored sample was apparently slightly less effective than the corresponding uncolored sample. The present writers believe that the difference so indicated, except where noted in the tables, were of the same order that might be obtained in duplicate tests of a single sample.

Tests of the calcium arsenates against cotton insects are listed in Table 1; those of the lead arsenates against codling moth and gypsy moth are listed in Table 2. Other tests are mentioned in the text.

Notes on tests of calcium arsenates. R. C. Gaines, summarizing all tests against cotton insects, stated that "the addition of certain coloring materials to standard calcium arsenates did not change their toxic effect upon certain cotton insects." However, it should be pointed out that F. F. Bondy, reporting his tests at Florence, S. C., (see Table 1) said, "it seems that the colored calcium arsenates are not as effective as the white calcium arsenate in boll weevil control." He added that it was a poor year for the tests and that, consequently, no definite conclusions should be drawn. The present writers believe the results of tests at Tallulah are the most dependable of those on cotton insects and justify the general statement by R. C. Gaines quoted above.

As to dusting qualities of the various samples, R. C. Gaines stated: "No difference was noted in the dusting qualities of the colored and uncolored calcium arsenates furnished by the General Chemical Company, Grasselli Chemical Company, Niagara Sprayer Company, and Commercial Chemical Company. The white and the two colored calcium arsenates furnished by the Lucas Kil-Tone Company made good dust clouds, but a better dust cloud per pound of dust used was made by the white calcium arsenate."

When injury to cotton plants occurred, the colored and uncolored calcium arsenates were equally injurious.

In a number of plots observations were made on infestation of cotton plants by the cotton aphis. In no case was there any substantial difference in the degree of infestation of plots treated with colored and uncolored calcium arsenates.

At Takoma Park, Md., the relative toxicity of 10 colored and corresponding uncolored samples of calcium arsenate was determined by J. W. Bulger in the laboratory against silkworms. A sample from the General Chemical Company colored by about 0.25 per cent of Erie Fast Scarlet was decidedly more toxic than the corresponding uncolored sample. Unfortunately, since this colored sample was not tested in the field, information on its practical value is not available. A sample from the Niagara Sprayer and Chemical Company containing bentonite 0.5 per cent and Safranine Y Extra 0.04 per cent appeared to be slightly more toxic than the corresponding uncolored sample. However, no such difference was noted in tests against cotton insects (see Table 1). The other 8 colored samples did not differ materially in toxicity from the corresponding uncolored samples. Erie Fast Scarlet and Safranine Y Extra when tested alone were not toxic to silkworms at high doses. The increase in toxicity of calcium arsenate colored with Erie Fast Scarlet was therefore not due to the toxicity of the dye itself, but to some change in the arsenical. Analysis of these colored and uncolored samples by the Insecticide Division did not reveal any difference in composition that could account for the difference in toxicity.

At Takoma Park, Md. it was observed that a sample of calcium arsenate colored with Lithol Rubine B (Grasselli Chemical Company) faded to a pale pink after having been placed in an exhibition jar and exposed to subdued light in the laboratory for several weeks. This observation indicates that the Manufacturing Chemists' Association should study the surface fading of colored arsenicals when exposed to light in bulk, lest the warning value of the color be lost.

Notes on tests of lead arsenates. E. J. Newcomer summarized his tests against codling moth on apple as follows: "Laboratory tests of green and uncolored lead arsenates did not show any particular difference in control, either immediately after spraying or at the end of seven days. In the field tests, both

with and without oil emulsion, the green lead arsenate resulted in slightly better control than the uncolored lead arsenate. Analyses for arsenic (As_2O_3), however, showed slightly higher residues from the uncolored lead arsenate. No injury of any kind was noted from either material."

A. J. Ackerman, who also made tests against codling moth on apple, submitted the following summary: "The results of these tests indicate no increase or decrease in codling moth control from the colors added to the arsenates of lead. No injury could be found on any plots. The colored materials appeared to produce a slightly more blotchy spray coating but this factor may be beneficial in control work."

S. F. Potts concluded from his laboratory tests against gypsy moth that "the dyes used neither lowered nor increased the toxicity of the arsenicals to any appreciable degree." With regard to the Ansbacher-Siegle green colored with sodium bichromate and Prussian blue, he said, "This material gave considerable foliage injury to sprayed twigs and when sprayed or dusted twigs were exposed to rain the material adhered very poorly as compared to the other materials."

C. E. Hood, who conducted the field tests against gypsy moth, came to the same conclusions as S. F. Potts. He found the Ansbacher-Siegle green "very unsatisfactory, being very granular and so coarse and heavy that very little of the material remained on the foliage after spraying was completed." The Ansbacher-Siegle green gave poor control of gypsy moth larvae and severe injury to oak foliage.

P. K. Harrison at Baton Rouge, La. tested the samples listed in Table 2 (except Ansbacher-Siegle green) for plant injury on tomato, corn, and soybean. The Lucas Kil-Tone products were also applied to peanut and lima bean. He found that "there is little, if any, difference in plant injury between the white and colored lead arsenates." He also noted that the residues of the colored arsenicals on the plants could not be distinguished from those of the uncolored arsenicals. Other workers made the same observation. C. E. Hood, however, noted a tinge of color in the residues of General scarlet, Grasselli red, and Niagara green and observed that the colors faded in a few days. The residue of General green was white at the outset and that of Ansbacher-Siegle green nearly matched the color of the foliage.

J. W. Bugler at Takoma Park compared the toxicity of 10 colored lead arsenates with that of the corresponding uncolored samples. No significant differences were found. The Ansbacher-Siegle green lead arsenate was not received here.

Summary and Conclusions

By special arrangement with the Manufacturing Chemists' Association, the Bureau of Entomology during the season of 1932 made practical field tests of 8 different samples of colored calcium arsenates and 8 different samples of colored lead arsenates for the purpose of determining whether the arsenicals so colored could be used in place of standard uncolored arsenicals. These and other colored samples were also given laboratory tests.

In so far as this report is used by the Manufacturing Chemists' Association as a basis for the selection of dyes or pigments suitable for coloring arsenicals, it is believed that a choice should be made among colored samples that were given practical field tests. Of these 16 samples, none can be definitely eliminated from consideration on the basis of present results. The usableness of only one sample was seriously questioned by the workers involved; i.e., lead arsenate colored green with sodium bichromate and Prussian blue (Ansbacher-Siegle Corp.). Unfortunately the corresponding uncolored sample was not compared with it in the field tests against gypsy moth. It is to be understood that in no case can the results of one season's tests be considered conclusive.

Table 1. Comparative tests of colored and uncolored calcium arsenates against cotton insects.

Dye or Pigment			Source of Sample	Sample tested by	Location of tests	Effect on Cotton Plants	Test insect	Result 5/	
Name	Colour Index Number	%						Field 1/	Lab. 2/
Carbon black	——	1.0	Lucas Kil-Tone	Bondy	Florence, S.C.	Not reported	Boll weevil	-	n.t. 4/
"	——	1.0	"	Smith & assts. Young & Garrison	Tallulah, La.	None	"	+ 3/	+
"	——	1.0	"	Dunnam & Moreland	College Sta. Tex.	"	Boll Worm	n.t.	-
#90 Carbon black	——	1.0	Grasselli	Bondy	Florence, S.C.	Not reported	Boll weevil	-	n.t.
Lamp black	——	0.75	Commercial	Smith & assts. Young & Garrison	Tallulah, La.	None	"	- 3/	-
Carbon black	——	Not stated	General	Dunnam & Moreland	College Sta. Tex.	"	Boll Worm	n.t.	+
Calcocide green C		0.5	Lucas Kil-Tone	Bondy	Florence, S.C.	Not reported	Boll weevil	-	n.t.
"		0.5	"	Smith & assts. Young & Garrison	Tallulah La.	None	"	+ 3/	+
"		0.4	"	Dunnam & Moreland	College Sta. Tex.	"	Boll Worm	n.t.	+
Naphthol green B	—5	0.15	Grasselli	Bondy	Florence S.C.	Not reported	Boll weevil	-	n.t.
"	—5	0.15	"	Smith & assts. Young & Garrison	Tallulah La	None	"	+ 3/	+
Acid green B 22675	1078	0.175-0.20	General	Bondy	Florence S.C.	Not reported	"	-	n.t.
"	1078	0.175-0.20	"	Smith & assts. Young & Garrison	Tallulah La.	Equal injury	Boll weevil	- 3/	-

none

Table 1. (Con't.)

Dye or Pigment			Source of Sample	Sample tested by	Location of tests	Effect on Cotton Plants	Test insect	Result 5/	
Name	Colour Index Number	%						Field 1/	Lab. 2/
Acid green B 22675	1078	0.175-0.20	General	Dunnam & Moreland	College Sta. Tex.	None	Boll Worm	n.t.	-
"		0.175 0.20	"	"	"	"	Leaf Worm	=	n.t.
Acid green B 25397		Not stated	"	Smith & assts. Young & Harrison	Tallulah La.	Equal injury	Boll Weevil	+ 3/	+
"	1078	"	"	Dunnam & Moreland	College Sta. Tex.	None	Boll Worm	n.t.	+
"		"	"	"	"	"	Leaf Worm	=	n.t.
Calcocide green CCC	none	0.115	Chipman	Smith & assts.	Tallulah, La.	Equal injury	Boll weevil	n.t.	+
Sheele's green	———	20.0	Ansbacher-Siegle	Smith & assts.	"	None	"	"	-
Safranine Y Ex.	841	0.04	Niagara	Bondy	Florence S.C.	Not reported	"	+	n.t.
Bentonite	———	0.5							
"	———	0.04	"	Smith & assts. Young & Garrison	Tallulah La.	None	"	+ 3/	-
	———	0.5							
Calcocide C E	652	0.4	Chipman	Smith & assts.	"	Equal Injury	"	n.t.	-
Bordeaux mixture		Not Stated	Ansbacher-Siegle	"	"	None	"	"	-

1/ Evaluation of field tests based on yield of cotton.
2/ Evaluation of laboratory tests based on insect mortality. Field cage tests are included in the term "laboratory tests."
3/ Field tests were made by M. T. Young and G. L. Garrison, laboratory tests by G. L. Smith and assistants.
4/ Not tested.
5/ Result of comparison with uncolored product of same company.

Table 2. Comparative tests of colored and uncolored lead arsenates against codling moth and gypsy moth

Dye or Pigment			Source of Sample	Sample tested by	Location of tests	Effect on Plants	Test insect	Result 5/	
Name	Colour Index Number	%						Field 1/	Lab. 2/
National green B 15418 none		0.20-0.25	General	Newcomer	Yakima, Wash.	None	Codling moth	+	=
Calcocide Green B L none		0.5	Lucas Kil-Tone	Ackerman	Springdale, Ark.	"	"	+	n.t. 6/
Iron oxide	—	0.5	"	"	"	"	"	+	"
Graphic red	—	0.1	"	"	"	"	"	+	"
Sodium bichromate	—	Not stated	Ansbacher-Siegle	Potts 3/ Hood	Melrose Highlands, Mass.	Considerable	Gypsy moth	? 4/	-
Prussian blue	—								
Malachite gr. 657		0.1	Niagara	"	"	None	"	? 4/	=
Bentonite	—	1.0							
Lead chromate	—	1.0							
National green B 15418 none		0.20-0.25	General	"	"	"	"	+	+
Erie Fast Scarlet 326		0.20-0.25	"	"	"	"	"	+	+
Lithol Rubine B ?		0.075	Grasselli	"	"	"	"	-	? 4/

1/ Evaluation of field tests against codling moth based on fruit counts; against gypsy moth based on mortality curves.
2/ Evaluation of laboratory tests against codling moth based on larval entrances and stings; against gypsy moth based on 50 per cent points of mortality curves. Application 3 lbs. to 100 gallons.
3/ Laboratory tests by S. F. Potts; field tests by C. E. Hood.
4/ Corresponding uncolored sample not tested. Ansbacher-Siegle green objectionable (see text).
5/ Result of comparison with uncolored product of same company.
6/ Not tested.